

Codes, Standards, Recommended Practices, and Guides of Engineering & Scientific Professional Societies: Application to Verification & Validation in Computational Engineering

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Special Topic Session T7
V&V Policies, Guides, Handbooks & Standards

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OUTLINE

- **Introduction**
 - **Why Standards**
 - **Who Makes Standards**
 - **Legal and Practical Implications of Standards**
 - **American National Standards Institute (ANSI)**
- Professional Society Standards Procedures Overview
- Professional Societies with Verification & Validation Activities
- Thoughts on Future Directions of V&V and Standards

Why Standards

- Standards are a vehicle of communication for producers and users. They serve as a common language, defining quality and establishing safety criteria.
- Costs are lower if products are standardized; training is also simplified.
- And consumers accept products more readily when they can be judged on intrinsic merit.

Who Makes Standards?

- The American National Standards Institute (ANSI) does not itself develop standards; rather it facilitates development by establishing consensus among qualified groups.
- ANSI ensures that its guiding principles -- *consensus*, *due process* and *openness* are followed.
- More than 175 distinct entities currently accredited under one of the Federation's three methods of accreditation (organization, committee or canvass).
- In 1999, the number of American National Standards increased by nearly 5.5% to a total of 14,650 approved ANS

Legal Implications of Standards

Inclusion of standards in performance contracts improves communication.

If a business contract includes a standard, the four possible outcomes, regarding the standard, are:

1. The standard was observed, and the results are satisfactory.
2. The standard was *not* observed, and the results are satisfactory.
3. The standard was observed, and the results were *not* satisfactory.
4. The standard was *not* observed, and the results were *not* satisfactory.

Caveat: “Anyone can sue anyone for anything at anytime.”

Practical Implications of Standards

A standard can translate into an economic force that sets **minimum** requirements.

Example: Would you consider the implantation of a non-compliant life saving medical device, over a compliant device, even if it was free?

AMERICAN NATIONAL STANDARDS INSTITUTE

- **Mission** - The Institute's mission is to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and **conformity assessment** systems, and safeguarding their integrity.
- **Annual Budget** - \$16 million (approximate) with over 75 employees.
- Represents USA at the International Standards Organization (ISO)

OUTLINE

- Introduction
- **Professional Society Standards Procedures Overview**
 - Organization
 - Forms of Committee-Generated Documents
 - Committee Procedures
 - Consensus, Due Process and Openness
 - Initiation of a Standards Activity Committee
- Professional Societies with Verification & Validation Activities
- Thoughts on Future Directions of V&V and Standards

TYPICAL STANDARDS ORGANIZATION

American National Standards Institute

American Society of Mechanics Engineers

Council on Codes & Standards (5)

Supervisory & Advisory Boards (10)

Committees (>100)

Members (>4000)

TYPICAL STANDARDS COMMITTEE

- Committee is composed of engineers with knowledge and expertise in a particular field.
- Representing users, manufacturers, consultants, universities, testing laboratories, and government regulatory agencies.
- Voting procedures for the standards committees are designed to ensure **consensus**.
- Proposed standard is subject to a public review.
- Standards are **living documents** that are constantly revised.

Committee Documents

- **Code** – an enforceable standard.
- **Standard** - a set of technical definitions and guidelines – ‘how to’ instructions for designers and manufacturers; verify compliance.
- **Recommended Practices** – evolve into standards.
- **Guides** - evolve into recommended practices.
- **Special Project Reports** – supporting documents.

COMMITTEE PROCEDURE

- **Consensus** – substantial agreement.
- **Due Process** – hearing and appeals board.
- **Openness** – public committee meetings and comments on committee documents.

INITIATION OF A STANDARDS ACTIVITY COMMITTEE

- Ad Hoc Committee Formation – survey existing standards and societies.
- Petition to Form a Standards Committee – document describing the who, what, where, and why.
- Submission of the Petition and Review – review can take many months.
- After the Petition – draft rules of operation.

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- Professional Society Standards Procedures Overview
- **Professional Societies with Verification & Validation Activities**
 - **American Institute of Aeronautics and Astronautics (AIAA)**
 - **American Nuclear Society**
 - **American Society of Mechanical Engineers (ASME)**
 - **ASTM International**
 - **European Research Community On Flow, Turbulence And Combustion (EUROFAC)**
 - **Institute of Electrical and Electronics Engineers (IEEE)**
 - **Society for Computer Simulation International**
 - **United States Association for Computational Mechanics (USACM)**
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AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

- Computational Fluid Dynamics Committee on Standards
 - **Scope:** Standardization in the field of computational fluid dynamics (CFD) for the purpose of promoting improvement in efficiency and productivity.
 - **Chairman:** Raymond Cosner
(raymond.r.cosner@boeing.com)
 - In 1998 this Committee published a **consensus guide** on V&V in CFD: “*Guide to Verification and Validation of Computational Fluid Dynamics Simulations*” (G-077-1998)

AIAA (continued)

- AIAA Software Reliability Working Group
 - AIAA is in the process of negotiating a means to revise and update the “Recommended Practice for Software Reliability” in cooperation with the IEEE Reliability Society.
 - **Contact:** James E. French (jimf@aiaa.org)

AMERICAN NUCLEAR SOCIETY

- Mathematics & Computation Division
 - Chair: Richard Sanchez
(richard.sanchez@cea.fr)
 - “*Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry*”
 - Detailed checklists for each phase of the described V&V process.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

- Board on Performance Test Codes #60 -
Committee on Verification and Validation
in Computational Solid Mechanics
 - **Chair:** Len Schwer (Len@Schwer.net)
 - **Charter:** To develop standards for assessing
the correctness and credibility of modeling
and simulation in computational solid
mechanics.
 - Eight *Special Topic Reports*

ASME (continued)

- ASME Fluids Engineering Division
 - The Coordinating Group on Computational Fluid Dynamics was formed in 1988 to address fluid dynamics issue related to computations.
 - **Chair:** Urmila Ghia (urmila.ghia@uc.edu)
 - “*Editorial Policy Statement on the Control of Numerical Accuracy,*” **Journal of Fluids Engineering.**

EUROPEAN RESEARCH COMMUNITY ON FLOW, TURBULENCE AND COMBUSTION

- EUROFAC - To be the leading European association of research, education and industry groups in the technology of flow, turbulence and combustion.
- Special Interest Group 101: Quality and Trust in Industrial CFD:
 - Best Practices Guidelines, Version 1.0, was issue in January 2000.
 - A compilation of CFD calculations of a range of test cases chosen for their industrial/end-user interest.

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FUTURE DIRECTIONS OF V&V AND STANDARDS

- Why is V&V such a **HOT** topic?
 - Less Physical Testing
 - Increased Product Liability
 - Increased Self-Certification
 - From Developer/Analyst to Black-Box/User
- “How valid are those results?”
 - Enlightened management will require an informed and measured answer.

FUTURE DIRECTIONS

- Most pressing need in V&V is validation.
 - Precision Testing – validation experiments.
 - Validation Metrics – meaningful comparisons.
 - Role of Non-Determinism – *nothing* is certain.
- Need for education in the area of experimental mechanics
 - Few practicing experimental mechanics
 - Lack of university laboratory training

FUTURE DIRECTIONS

- EUROFAC Model Organization - appears to be developing a very sensible, and economic, method of operating a verification and validation organization.
- Only the Government *can* afford the financial burden of full V&V programs.
- Business model for a future V&V organization is probably a non-profit organization funded by subscriptions and Government support.